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ART. I. — 1. *Food and its Adulterations; comprising the Reports of the Analytical Sanitary Commission of "The Lancet," for the Years* 1851 *to* 1854, *inclusive.* By ARTHUR HILL HASSALL, M. D., Chief Analyst of the Commission. London: Longmans. 1855.

2. *The London Lancet, from* 1854 *to* 1861.
3. *A Treatise on Food and Diet.* By JONATHAN PEREIRA, M. D., F. R. S.
4. *What we Eat.* By THOMAS H. HOSKINS, M. D. Boston: T. O. H. P. Burnham. 1861.
5. *The Theory and Art of Bread-Making: a new Process, without the Use of Ferment.* By E. N. HORSFORD, Rumford Professor in Harvard University. Cambridge. 1861.

AMONG those amusing caricatures of Parisian life and manners, written by a choice corps of native wits and *feuilletonistes*, and illustrated by Gavarni, which are collected into a volume under the significant title of *Le Diable à Paris*, is one picture of a low eating-house in the *banlieue*, or outskirts of the city. The dirty and puzzled *garçon*, meanly clad, hot, hurried, and with the inevitable long napkin dangling from his left arm, has paused from his usual half-trotting gait, and, standing with his chin buried in his hands, in an attitude of profound contemplation, is trying to solve this problem in what is called the *Arithmétique de Gargote*: "Étant donnés trois chats, dont une chatte, on demande six gibelottes?"

Perhaps it is among the least wonderful transformations of the French *cuisine*, "having given three cats, — of whom one a female, — to make six rabbit stews"! Such metamorphoses, to say the least, are harmless, if they are repulsive. Every department of modern science can show as strange ones, from the sparkling gelatine made from the hoofs of decrepit hack-horses and filthy sheep's trotters, to the delicate *gants de société*, of the purest white, tanned from the back of a rat from the Paris sewers.

Nor are these changes, when healthy and lawful, to be deprecated, — they even challenge our admiration; for they add so much to the stock of human production, and hence save as much from the waste of life for ever-pressing human needs. Chemical transmutation is cleaner than water; and a reaction or a precipitation engenders perfect change and purity. Our sugar may be clarified with the albumen in ox-blood, and yet be, absolutely and simply, white sugar. Our flour may be fermented and raised by the growth of a disgusting fungus, the yeast-plant, and yet become palatable and wholesome bread. Nature does likewise in the fields, when she converts her own decaying remains, vegetable mould, the excretions and even the dead bodies of all her children, to her sweet uses in making grass and grain and trees. The chemist but imitates Nature; extorting her secrets by analysis, and then using them in his syntheses, as far as his art can go. But it is when changes are made or substances added to deceive or defraud, that we speak of falsification or *adulteration*.

In the earliest ages men lived as simply as the brutes around them. Milk, the raw flesh of animals, acorns, ground-nuts, and fruits, formed the only varieties of their diet. But the human stomach has not, even in a savage state, the digestive capacities of that of the lion or the ox. The one, seizing and swallowing his prey in crude masses, sinks into a lethargy of hours until the stomach has become empty; the other, while laboring all day in taking the requisite amount of pasturage into his system, has still to devote the night to its rumination and solution. Man, though obviously omnivorous, does not equal in digestive power the pig, which most resembles him in the universality of his food, but needs extraneous aid for his organs of mastication. His food must be presented to him in a soluble and easily divisible state. To accomplish this with meats, and still more with any starch-containing articles,—to disintegrate the masses of solid muscle into their smaller *fasciculi*, and to crack the otherwise impregnable starch-cells, the influence of heat is necessary. Hence the art of cooking arose, probably, as early as any act not purely natural.

With cooking came, soon after, the mixing and refining of food. The good old diet of roasted beeves, and of corn, wine, and oil, gave way to other methods. Bread, vegetables, condiments, followed in due course. Many new articles were discovered, or their use invented. Fish and game were added to the meats; rye, barley, arrowroot, sago, rice, maize, and the potato, to the simple cereal. As soon as these various substances began to be gathered into masses to supply large communities, and to be prepared for the market, the temptation to alter, falsify, or adulterate them had its origin. And this is an evil which has increased in the same ratio with the culture of the race.

Not satisfied with food alone, the human race soon sought for stimulants; and from alcohol the step was short to narcotics, as the hop, cocoa, betel, hemp, and opium.

After a much longer period, it was discovered that many minerals were conducive to man's needs, and they came into familiar and daily use. Many were innocent; but many also poisonous, by contact or proximity. Besides iron, tin, and other useful metals, were introduced lead, copper, arsenic, and phosphorus, substances eminently toxical. As civilization progressed faster than sanitary knowledge, mankind began to be gathered into houses, and forthwith to shut out the pure external air and to suffer from bad ventilation. Finally, with the change from the nomad life to the permanent abode, came the dangers of careless and imperfect drainage.

These great social evils — the Adulteration of Food, the bad influence of Narcotics and of Mineral Poisons, the lack of Ventilation, and imperfect Drainage — may be called the ENEMIES OF CIVILIZATION. They follow and blight all its great advances in physical and social well-being; and, as our nearest, ever-present, and most deadly foes, they demand constant vigilance and attention. We propose to speak now of the first only.

We might fairly parody that famous description of the British subject as taxed in every article of food, of wear, of amusement, and of daily use, from his cradle to his coffin, and make out an equally strong case in the matter of adulteration. From morning to night he is the subject of perpetual fraud. He shaves himself with an inferior imitation of some high-priced soap; puts on a coat made of shoddy, and a hat of silk imitation of beaver. He drinks chiccory and beans in his coffee, water in his milk, and organic matter of the vilest kinds, with the animalcules which are its scavengers, in the water itself. He may reasonably expect to be poisoned with his wines and liquors; but he is unsuspicious that he is eating lard in his butter, alum in his bread, disgusting parasites, flour, and gypsum in his sugar, meal in his mustard, turmeric in his ginger, sulphuric acid in his vinegar, lead in his cayenne, copper in his pickles, gelatine in his isinglass, potato-starch in his arrowroot, and many mineral poisons in bonbons and confectionery, — or that his potted meats may be made of horse-flesh, his tea of used leaves revamped, his cigar falsified, and his cocoa adulterated with meal and flour.

This is literal truth. Nothing, we may say, in the whole domain of Nature, has escaped this universal contamination. The voluminous pages of Mr. Hassall's fearful work teem with proof that nothing is too small, nothing too cheap, nothing too common, familiar, or indispensable, not only to comfort, but to existence itself, to be spared from fraud. Nay more, adulteration is re-adulterated: coffee is adulterated with the cheaper chiccory, and chiccory itself with still cheaper roasted corn. The adulterer is himself defrauded by a still more cunning swindler; and "while he is picking his customer's pocket, in fancied security, some other knave is deep in his own."

Partial discoveries, unintentional revelations, marvellous cheapness, and disproportionate fortunes sprung from humble trades, had long since generated a vague distrust in the public mind. This feeling, however, extended only so far as to lead to a doubt whether some articles were not mixed with inferior articles of the same kind, but never to a suspicion that foreign substances, and even poisons, were employed to adulterate and defraud. But this distrust must have always remained vague and uncertain, nor could proof have ever been adduced convincingly and publicly, save for two things. Of these, one might have satisfied the mind of science, but would never have spread with telling effect among the guilty, and throughout the whole country, without the support of the other. The former was the improvement in the accuracy of the microscope; the latter, a fearless and incorruptible public journal.

The chemist's power is weaker in the organic, than in the inorganic world. There is reason to fear that it will long remain so. He is at present baffled chiefly by the similarity and complexity of organized substances. Most organized existences or materials, animal or vegetable, living or dead and disintegrated, are made up of the four organogens, Carbon, Hydrogen, Oxygen, and Nitrogen. Their varieties consist mainly either in the absence or presence of nitrogen, or in the number of atoms composing their different parts. Some too, with identical composition, differ apparently in the arrangement of their atoms, as sugar and starch. The other difficulty, their complexity, arises from the large number of equivalents of each element which composes them, and from the manner in which they are mingled with other organic substances lacking decisive tests. Add to this their tendency to decompose and form new and varying compounds under the influence of re-agents, and we have sufficient reason why the results of organic qualitative analysis in certain fields are hardly more determinate than the experiment of the facetious chemist who tried to analyze a whole mouse. We can conceive that it may be much more difficult to find and extract unchanged a compound body like chiccory, which is made up of the four organogens in large equivalents, and perhaps half a dozen other elements, which we may call extractive, coloring, resinoid, or saline matters, than to eliminate one of the simple metals, as lead or copper. Then too, among the varieties of cereal adulteration with potato, meal, sago, or rice flours, no difference can be detected chemically, since starch is starch in the one, as in the other, and can give, perhaps, its only test of turning blue with iodine. In such cases as the adulteration of flour with alum, it is true that chemistry can alone eliminate it; but, in general, organic analysis is uncertain, while organic synthesis utterly fails.

Without some other power, it would, then, be obviously impossible, as it was till our own time, to detect the adroit adulteration of alimentary substances. That power the convex lens has conferred. The labors of many zealous experimenters have at last elevated the microscope from a mere plaything to a truly scientific instrument; from the simple to the compound microscope; from a single convex glass, held over objects by the hand, to the wonderful combination of lenses and chambers, mirrors, tubes, diaphragms, stages, fine adjustments, eye-pieces and objectives, which rival, in an opposite direction, the power and the accuracy of the telescope itself.

Is it not wonderful that the fine dust shaken from the moth's wing will resolve itself into feathers of the same bipennate form which we see, with slight magnifying, upon his back; and, under a still higher power, into a series of lines, and *striæ* or markings, regular as a mathematical scale, yet only a thousandth of an inch apart, and as clear and sharp as if cut by those Egyptian tools whose markings stand thousands of years, but whose material was buried with the lost arts? The perfected microscope may be likened to a quickened eye, gifted with vast range of vision, yet equally capable of defining the faintest trace upon its transparent retina; whence, again, the more wondrous human retina absorbs the image from its mirror, and photographs it unchanged upon the brain. The chromatic aberration, and the aberration of sphericity, were the last errors to be corrected. But as the improved microscope exists now, it defines and illuminates, as well as magnifies, void of color or irregularly refracted rays. Escape from its searching eye is hopeless for any living or dead atom of that microcosm which constitutes its impalpable "object." From 20, to 400, to 800, to 1200, and more diameters, may the obdurate substance be unfolded, until its last complexity is laid bare, and everything but homogeneity yields to the resolving power.

Yet all this would be unavailing to detect adulteration if a grain of starch were a grain of starch, whether flour or potato, and if there were no distinctive differences in appearance. Fortunately, Nature is too expert a worker not to leave her impress upon everything she has made. There is no counterfeiting her trade-mark. A grain of starch is not a grain of starch, if grown on a different plant, however much it may seem so to the chemist, or to the careless eye. Wheat, rye, barley, oats, potatoes, rice, Indian corn, arrowroot, and lentils all contain starch; but their starch-granules, though bearing a family resemblance, are all distinguishable from one another under the microscope. Subjected to the same magnifying power, of say 420 diameters, they may be seen to differ plainly and unmistakably in size, in shape, and in their markings. Once learned and readily recognized, what a dictionary of terms we have already in our search for adulterations? So it is with everything else. Tea may be verified by the microscopic venation of its leaves, spices by their varying woody fibres and cellular structure, minerals by their crystalline form. Chiccory and coffee may be unerringly discriminated by their cells and spiral vessels; the acorn, by its stellate granules; cocoa and potato-starch or sago, by the granular state of the one cell, and the concentric markings of the other. So far, indeed, has this been carried, that the pollen-grains of flowers can be detected in honey; and, since they too have each their distinctive marks and shape, the kinds of flowers from which the honey was culled can be recognized, and it can be known whether the bees gathered it in the meadow, or on the heath.

Moreover, these are not transient images which the microscope affords. We are enabled, by the *camera lucida*, to project the image upon paper, and trace it out while still under examination. Thus engravings of microscopic objects may be reproduced, second only in accuracy to the photograph. This has been done very fully in Dr. Hassall's report; and, by the aid of the very numerous illustrations therein contained, any novice may verify, with his microscope, the purity of his articles of food, or the reverse.

So far, then, it was easy by careful and repeated examinations to detect adulterations. But this was not all; it was necessary to give to these scientific details a publicity and interest, to explain examples, to insist on their importance, and, finally, to denounce the guilty. And this is what the London "Lancet" has done. Such rare integrity and courage deserve more than a passing notice.

Dr. Hassall, being particularly struck with the condition of ground coffee, as bought in London, was led to make some microscopical examinations of it. This first trial demonstrating to him the fact that it was adulterated with chiccory, and, moreover, that ground chiccory could be readily distinguished from ground coffee, he determined to pursue his investigations among other articles, and turned his next attention to sugar. A notice of these early inquiries was inserted in the London Times.

Meanwhile Mr. Wakley, of the Lancet, decided to publish the names and addresses of all tradespeople whom Dr. Hassall might convict, microscopically, of adulteration; and the whole series of papers on various kinds of food, placed first at the head of this article, was published in the Lancet, under the title of "Analytical Sanitary Commission," from 1851 to 1854. "It is impossible," says Dr. Hassall, "to speak in too high terms of the great moral courage of Mr. Wakley in this course which he pursued." Of his motives, the editor of the Lancet thus speaks for himself: —

> "That the various articles of consumption differ greatly in quality, and are subject to numerous adulterations, must be evident to all, from the slightest consideration and examination of the subject; and if any general proof were wanting to establish the truth of this position, it would be found in the low and unremunerative prices at which very many commodities, to be genuine, are now commonly sold. That, therefore, there is much relating to our food and drink requiring exposure and remedy, cannot be doubted.
>
> "We propose, then, for the public benefit, to institute an extensive, and somewhat rigorous, series of investigations into the present condition of the various articles of diet supplied to the inhabitants of this great metropolis and its vicinity. One especial feature of these inquiries will be, that they are all based upon actual observation and experiment: the microscope and test-tube throughout these investigations will be our constant companions. A second feature will consist in the intro-

duction of faithful engravings, illustrating all the more important particulars relating to the structure of each article as determined by the microscope. A third and highly important feature will be the *publication* of the *names* and *addresses* of the parties from whom the different articles were purchased: the advantages of such a course of proceeding require little explanation. Experience has shown, that any merely general exposure of the nature of the adulterations practised on the public through their food, is not sufficient to deter from a repetition of them; and that the only way in which it can be hoped that such fraudulent practices can be stayed, and the public protected, is by such proceedings as will entail personal discredit and probable loss. Now, although we are fully and firmly determined to protect the interests of the public, we, at the same time, do not desire to inflict injury on any one, as a proof of which we shall refrain from giving any names of adulterators for the space of three months from this date, and shall, at present, in connection with the analyses, merely indicate the street in which each vitiated commodity was purchased.

"The urchin who filches a bun, a penny-piece, or the value of one, breaks the law, and is liable to punishment, even imprisonment, — is it to be supposed, therefore, that the cunning and systematic adulterator of our food and drink, who robs us, not only of our money, but sometimes also of our health and strength, is less guilty? that he is to be allowed to violate the law with impunity in his daily dealings, and not only to go unpunished, but to carry about with him, as at present he commonly does, in his intercourse with his fellows, the undeserved reputation of an honest man? That the law, while it rigorously punishes the trivial offender, should allow the greater criminal to go at large unscathed, is an insult to common-sense. But the question is not merely one of honesty and dishonesty, of profit and loss, it is also eminently sanitary; one of health, and even, in some cases, of life itself." — *Introductory Remarks.*

The exposure was vigorously and fully carried out. The names and addresses of the vendors of every article examined, whether genuine or adulterated, after the expiration of the stated three months, were relentlessly published, and read throughout the whole of London and vicinity. In many cases, also, extracts were given, in the great capitals and italics of the advertisers, from the laudatory placards and labels describing articles which proved to be of the basest kind. As, for a single instance: —

"18*th Sample.* — 'Stratton's improved soluble Cocoa; which requires no boiling. *A delicious preparation of the genuine cocoa-nut.* To obtain this pure preparation as invented by *us*, the sole manufacturers, it is requisite to see that our name is on the envelope, as some unprincipled firms have condescended to the meanness of imitating our labels.'

"*Analysis.* — 100 parts consist of about 13 parts of sugar, 45 *per cent of potato-flour and sago-meal,* and the rest cocoa."

And so on, *usque ad nauseam*, but we have no room for more. Here it may be noticed that, as a general rule, the amount of puffing was always in proportion to the badness of the article, — a useful hint to purchasers everywhere, and in more than one sphere of life.

One natural result of these exposures was the encouragement and advantage given to honest traders, who gladly placed the Lancet's stamp of "Genuine" upon their wares, as is done by one great London pickle house, even now. Again, all had an opportunity to reform their errors for three months before exposure, and honest retailers who were ignorantly selling an article adulterated in the manufacture, as spices or sauces, had time to change their stocks for better.

Of course the hundreds of detected rascals "raged and raved like wild beasts"; but with such demonstrative certainty did the deductions of the Lancet fasten themselves in the public mind, and so irrefragable was the proof, that only one party ventured to bring a suit for libel, and he withdrew it before trial. Several had the impudence to advertise, after exposure, that their coffee was now sold under two classes: one genuine, the other cheaper, as "mixed coffee," containing chiccory. Renewed analysis proved the "genuine" to contain chiccory; which fact being published, probably established faith in Dr. Hassall forever after. It is worthy of remark that, not long before these applications of the microscope, the Chancellor of the Exchequer said in Parliament that there was no known way of detecting chiccory in ground coffee.

The Excise in England is a cumbersome and costly system to protect the revenue, and hence should operate as a check on adulteration; but practically it had very little effect. It is gratifying to observe, however, that, after the publications in the Lancet, many imported articles were noticed at the custom-house to be much purer than before.

These horrors have not been much thought of in our vicinity. But any doubt as to whether they exist here as well as in England is at once done away by the little work of Dr. Hoskins. This is a very excellent, conscientious, straightforward, and condensed statement of the adulterations of food in Boston. All the accusations are said to be verified by experiment, and we have no doubt that this is true. The public owe their thanks to the author for the pains he has taken to protect their stomachs. We wish it might have some effect. But we have even less confidence in the vigor of our legislation and our executive than we have in that of England. Knowing the sharpness of the " universal Yankee," the low tone of commercial integrity in some great centres of trade, and the general lust for early wealth, we might expect adulteration to be as bad here as in other countries : and so we find it ; and in some respects worse.

Such things demand public discussion. With the reader's patience, we will run over the principal frauds in as exhaustive a manner as an article of this nature will admit. We shall speak first of the necessaries of life, because adulteration of these reaches the whole community.

At the head of the list is *Bread*, familiarly called " the staff of life " ; though, alone, it will not properly support life. Boussingault came to this conclusion from observing the small quantity of nitrogen which it contains ; and the reports on a diet of bread and water in prisons bear him out. Yet when butter is added, we have all the four necessary elements of nutrition, — the albuminous, the saccharine, the aqueous, and the oleaginous, represented by gluten, starch, water, and butter. Besides this, it is really the most universal food next to milk. The latter, it is true, is a wholly natural product, made to hand, and containing the four elements of nutrition in just those proportions needed by the system. It is curious to observe, in this connection, that all tropical nations, that live so largely on starch, always seek to obtain some oleaginous element to complete their food ; as is exemplified in the general use of *ghee*, or melted butter, among the Hindoos, with their perennial diet of rice.

Wheat consists mainly of starch and gluten ; the latter in higher proportion than in the other cereals. The gluten is that adhesive substance which is left in a spongy or ropy mass when flour is washed under a stream of water. It is a vegetable albumen, and contains nitrogen. It may therefore be regarded as, perhaps, the most essential element of the grain. In 100 parts of good wheaten flour there are from 56 to 72 parts of starch; from 10 to 14 parts of gluten; and from 3 to 6 parts each of gum and sugar. But wheats vary in richness acording to soil and cultivation, the gluten ranging from 9 to 34 per cent. In North American wheat it is set down at 22 per cent; and in the Western wheat, grown upon the virgin prairies, it is probably fully equal to that amount. According to various authorities, it appears that wheat contains much more of this principle than the other cereals, or the vegetables used for food. Thus, barley has of gluten 6 per cent; oats, 4 to 8 per cent; rye, 8 to 10 per cent; beans, 10 per cent; while rice has only 3 per cent; potatoes, 3 to 4 per cent; and Indian corn, 3 per cent. On the other hand, we find that the other grains make up in starch what they lack in gluten; as, wheat having an average of not more than 60 parts of starch in the 100, maize has 80, and rice 85 parts.

These comparisons sufficiently prove to us that very grave differences may be really produced in food by merely changing one for another among the different kinds of cereals, which might be regarded by many as a very innocent falsification. For, although recent experiments have overthrown the theory that animals can live on albumen alone, as the creatures starved whenever fed exclusively on either gluten or starch, yet it is probable that both have a certain distinct part to play in the human system, and that some proportions of them are more valuable to us than others. Although, too, physiology has recanted the theory that starch is *exclusively* a calorifacient, and albumen a plastic food, yet experiments leave no doubt that the former is digested in the duodenum, and the latter peculiarly in the stomach. It is easy to see, therefore, that the fraudulent and unrecognized substitution of the one for the other may make a very essential difference in the effects of diet on the sick, particularly in certain diseases where the stomach needs rest, while the duodenum can work; or where it is very undesirable, on the other hand, to give any starchy food at all. Especially will these dangers of substituting the various farinæ for one another be important and serious in the numerous alimentary affections of very young children. At the same time, theory and experience alike teach us that real wheaten bread is more nutritious as a food than rice or potato flour. Certain preparations too are really more digestible than others. Indian corn, for example, if more fattening, may be found less digestible, from the amount of oil it contains, and also from the fact that it does not contain gluten enough to ferment into raised bread. Fresh wheaten bread was found by Dr. Beaumont to be wholly digested in three hours and a half.

When we desire to convert wheat-flour into food, experience has always taught us that two processes are necessary, but it did not teach us the reason why. The flour must be fermented, or raised, and it must be baked. The feebler digestive power of man's stomach renders all this essential; otherwise he might masticate and digest his grain like the horse. The flour must be raised, to separate and open its constituent parts, to make it light and porous, and, finally, to imitate that cellular structure which is the universal condition of all organized matter that forms our food. The dough must be baked, to crack the starch-cells by heat. And both these changes from the simple grain are necessary, in order that the gastric juice may readily permeate every part of the food, and, finding the gluten distended by gas into thin cell-walls, and the starch opened and accessible, may be able to attack and digest them speedily and profitably.

The baked loaf we shall find to differ somewhat in its chemical constituents from the simple grain. According to Vogel's analysis it is as follows: Starch, 54 parts; torrefied or gummy starch, 18 parts; sugar, 4 parts; gluten, 21 parts; and also some carbonic acid, chloride of calcium, and chloride of magnesium. This bread was made of wheat-flour, distilled water, and yeast, with no other ingredients. The cause of these changes we shall presently see.

According to the little treatise on "The Theory and Art of

Bread-making," by Professor Horsford, the microscopic structure of a grain of wheat is somewhat peculiar. By examining a cross-section of a wheat-grain we find, first and outermost, several coats constituting the pericarp, or true bran, which contains but little nutritious matter ; next, an inner envelope, the gluten layer, containing cells of gluten, and constituting the true storehouse of this valuable ingredient; finally, inside of, and distinct from, the rest, and constituting the bulk of the seed, a mass of starch. The outer coats of bran may be removed by rubbing with a moist cloth, and really this is all that should be removed. The gluten contains the greater part of phosphates which are eminently necessary to nutrition, some of which are in the real bran, which contains also iron, magnesia, silica, and potassa, beside seven per cent of phosphoric acid. The ash of wheat, as a whole, has, in 100 parts, no less than 46 parts of phosphoric acid, 29 parts of potassa, 12 of magnesia, and 3 each of soda, lime, and silica.

Now the practical deduction from these details is this. It unfortunately happens that, in the process of bolting, very much of the gluten is removed with the bran, and thrown away ; and that the finer and whiter the flour, the more careful and thorough is the bolting, and the greater the loss in gluten. Therefore it is that bran has been found to contain, weight for weight, more than fourteen times as much phosphoric acid as the superfine flour that is bolted from it. This excessive waste includes, as we have said, gluten, and hence nitrogen, the most important distinctive elements of wheat. Hence it is that *unbolted* wheat-bread, or the black bread of Germany, is much more nutritious than pure, refined, white bread ; since the former contains all the gluten, all the phosphates, and all the nitrogenous compounds, as well as all the starch, while the latter has lost a large proportion of everything but starch. This loss being just in proprtion to the high quality and whiteness of the flour, "fancy brands" are thus far from economical for other reasons beside their greater cost.

When bread is to be fermented, a certain proportion of a peculiar liquid, called yeast, is added to start the process.

The fermenting qualities of yeast are owing to, or accompanied by, it is not quite certain which, the growth of a peculiar fungus, the *Torula cerevisiæ*, or yeast-plant. This vegetation develops cells with great rapidity, which, uniting end to end, form stems. By the operation of a principle called "catalysis," by which a ferment induces the same change in any substance with which it is brought in contact that it is undergoing itself, the dough takes on the process of fermentation. By this process several important chemical changes are induced. The starch is converted into dextrine, this dextrine into sugar, and a portion of the sugar into alcohol and carbonic acid. By the evolution of the latter gas the dough is distended with bubbles, and these are held in by their cell-walls. The starch does not possess tenacity enough to withhold the bubbles from escaping, which office is performed by the elastic gluten. Besides these changes, there are produced in fermented bread lactic, acetic, butyric, succinic, and formic acids; some ammonia; a pleasant ethereal oil; and also a greater or less liquefaction of the gluten. Of all these effects, the only essential one in raising the bread is the production of carbonic acid, and hence of a cellular structure, as it is diffused through the dough, and held by the tough gluten.

But as it was found that, with flours of inferior quality, — those poor in gluten, for instance, — the tendency of the fermentation was to liquefy the gluten so far that it could not hold the carbonic acid, so that the gas escaped, the dough collapsed, and the bread became heavy, as well as dark-colored and unsalable, it was a desideratum with bakers to find some substance which would prevent these ill results. Both sulphate of copper and alum will do it; the latter is generally used. "Alum combines with the albumen and renders it less soluble, and by so far arresting the effect of fermentation, in a twofold way, lessens the liquefaction of the gluten." It thus stiffens the cell-wall of gluten. The bread becomes more evenly and thoroughly raised, and, as a secondary effect, alum renders dark bread whiter. Thus an inferior flour will produce as handsome and salable a bread as a finer variety. These effects of alum often constitute the difference between baker's and home-made bread. With the extreme porosity of bread containing alum there is an excessive production of dextrine, or gummy starch, which makes the bread dry too rapidly, and gives the brittleness and hardness characteristic of the slice of baker's bread when exposed to the air.

Let us see if the bakers avail themselves of this cheap and unsuspected adulteration. Dr. Hassall, after alluding to the adulteration of bread with rice-flour and potato-flour, which are cheaper, says that a commodity is generally bought by bakers under the name of " hards," consisting of a mixture of alum and salt. One object of its use, he avers, is to enable the bread to retain more water, and thus to weigh more. Mitchell found, on analysis, that the quantity of alum in ten loaves of four pounds each varied from thirty-four grains to one hundred and sixteen grains to each loaf. This may be in excess of the quantity usually employed. Of twenty-four samples of bread examined by Dr. Hassall, *all were adulterated with alum.* Of four samples purchased of a League Bread Company, which specially advertised pure bread, without alum, *all* were adulterated with alum. Again, says Dr. Hoskins, " As the result of a careful analysis of bread bought in different parts of this city [Boston], *not a loaf was found free from alum.*" Comment is unnecessary.

We thus have found that the " staff of life," before it can reach the mouths of the people, is seriously injured in two ways: first, by bolting the wheat, which removes from the flour much of the gluten, and the greater part of the phosphates; secondly, by adulteration with alum. Professor Horsford suggests the probability of still other injuries as the result of fermentation, by the changes produced in the dough, and by the growth of fungi; but these are not proved. The use of alum is the only, or the chief, fraudulent adulteration. This defrauds the pocket, as well as impairs the goodness of the bread. By the use of inferior flour, it enriches the baker by knavery. It also exercises a more or less injurious influence on the stomach of the consumer. Alum is a powerful astringent, and almost an irritant, to the mucous membranes. It must then be very poorly adapted to a delicate stomach. After considering these facts in bread-making, we think that one would hesitate long before recommending the baker's loaf as lighter than home-made bread for the dyspeptic. If more perfectly raised, it is less nutritious ; and we have no question that the alum often produces irritation and heart-burn. It seems reasonable to suppose that the very large consumption of baker's bread in New England has some connection with that generally constipated habit of the bowels which is so prevalent here, but comparatively unknown where corn-bread is eaten, at the South and West. We call to mind one instance of a dyspeptic who has lived largely on alum bread, whose habitual constipation has grown more stubborn with years. At any rate, no one wants to eat alum instead of phosphates, and water instead of bread.

This is an important subject, and we cannot insist too strongly on the benefits of having good home-made bread. Various laws have been passed, but they are everywhere dead-letters, except in France. Paris bread is universally recognized as the best in the world: it is free from alum. As it is not always easy nor convenient to make good fermented bread, other ways have been devised of raising bread without fermentation, by the production of carbonic acid in the dough, under the influence of heat. All these kinds of bread are to be baked as soon as mixed. Among the more common devices are the mixture of saleratus, or bicarbonate of potash, with sour milk, or lactic acid ; and that of the bicarbonate of soda with cream of tartar, — an acid tartrate of potassa. If the salt and the acid are perfectly neutralized, it is all very well. A still better method was invented by Henry, consisting in the use of carbonate of soda and muriatic acid, the product of which would be common salt. Dr. Danglish has devised an ingenious mode of forcing into the dough carbonic acid in solution in water, in a closed apparatus. But this is not easily practicable on a small scale. The new method proposed by Professor Horsford seems chemically the most correct, though we have no practical acquaintance with its workings. It consists in mixing with the flour a dry, acid phosphate of lime and dry bicarbonate of soda, in such proportions as to leave a neutral phosphate of lime and phosphate of soda, after the dough has been baked. In this manner the phosphates lost in bolting are restored to the bread, and the evolution of carbonic acid is attained without fermentation, and without any injurious secondary results. All these methods are much quicker than fermentation.

We come now to the second great universal food, Milk. This is a compound fluid, and on this account any adulteration of it is not readily discoverable, as it may differ sensibly in the proportions of its several ingredients. Thus milk may be rich or poor; with caseine, or fatty matters, in large or small amount, and yet be genuine. A more serious difficulty is that admixture with other innocent fluids, as water, may hasten its decomposition, which is very ready to take place under the best circumstances. The chief adulteration of milk is with water; the others are of minor importance. Color is no sure test, since very blue, thin milk is made to look yellow by the addition of simple coloring-matters; neither is taste a positive guide; and we must seek for some other means for detecting this adulteration. Such a means is furnished by the lactometer, by which the purity of milk is determined from its specific gravity. Some doubts which have been expressed about the accuracy of this instrument arose from one or two incidental causes of error; such as a high temperature, or the presence of a large amount of cream, rendering the specific gravity less, since cream is very light. That it is the means made use of by the milkmen themselves in testing their stock when taken from the farmer, is pretty good proof of its trustworthiness. Dr. Hoskins, in particular, having devoted very considerable time and care to the question, has come to the conclusion, that within the limits proposed it is to be entirely depended upon. The lactometer is a specific-gravity instrument for fluids, or an hydrometer, having a graduation peculiar to itself. The stem is graduated from 0 to 25. 20 corresponds with the ordinary specific gravity of pure milk; and very nearly with 10.30 on the common hydrometer. If the lactometer floats in milk at 15, it is adulterated with 25 per cent of water; if at 10, with one half water; and so on. It is rarely found to vary more than three fourths of a degree from 20 in pure milk. Flour or starch, gum tragacanth, and turmeric are sometimes added to give density or color, and carbonate of soda to prevent incipient acidity.

Salt is a not uncommon, sheep's brains quite a rare, adulteration.

The nature of the cow's food has considerable influence on the milk. Carrots and beets increase the amount of sugar. Morbid matters and even pus-corpuscles have been found in the milk of diseased cows; and seven times the normal amount of phosphate of lime in the milk of cows with tubercular affections of the lungs. Grass or hay, fresh air, and some locomotion, are indispensable to the health of the cow and the purity of the milk. But in defiance of this law, cows are fed on the used grain of the distillery, and kept closely confined in improper stalls. Such has been the case to a limited degree in London, and such is the present state of things in New York. Cows are tied up by hundreds in the "swill-milk" stables, so closely that they must lie on each other when they try to rest; and they remain there until they die, or are taken out to be slaughtered as death approaches. They are fed upon the refuse of the distillery, smoking hot, and on no other food. This destroys their teeth, and soon establishes a profuse diarrhœa. The tail rots off, the intestines ulcerate, and life closes with destruction of the lungs. All this time the poor creatures are milked until nature is exhausted. The distillery slop increases the quantity of milk; but the quality is, of course, execrable. The specific gravity is not over 10.16, and the milk is always acid to test-paper. This vile compound is dealt out all over the city as pure country milk, and would seem to be sufficient of itself to account for the excessive mortality among children in New York. Exposure and remonstrance have alike proved unavailing. Attention was called to it more than thirty years ago; and it was then estimated that there were five hundred such dairies in New York and Brooklyn. In 1842, Mr. Hartley wrote a very thorough and scientific *exposé* of the system, in book-form; and some four or five years ago, the horrors of the swill-milk stable were portrayed in a series of illustrations in a New York journal, and the routes and numbers of the milk-carts which traded in this abominable commodity were given. But the state of things is said to be now as bad as ever.

Cheese does not seem to be capable of much adulteration;

though, of course, there is every quality of richness in it; as the Parmesan, or skim-milk cheese; the Cheshire, made from new milk; and the Stilton, made of new milk with the further addition of cream. Cheese is rich in proportion to the butter which remains with the coagulated caseine. It is properly made with the rennet of the calf. But it is not unfrequently falsified with pig's rennet, which gives it an unwholesome fermentation, and the use of which may be recognized by its leaving the cheese full of uneven and large cavities. Cheese sometimes is subject to a form of mould, or fungus, which is poisonous. It is often colored with *anotta*, the seed-capsule of a plant growing in Guiana. This furnishes an elegant red, harmless in itself. But *anotta*, we learn, is often adulterated with red ochre or powdered bricks.

Butter is adulterated with an excessive amount of salt, with water, and with lard. Dr. Hassall found the amount of water in samples he examined to range from 8 to 28 per cent, and a letter from an honest dealer informs him that water is added for weight to the amount of 50 per cent. It is incorporated by heating the butter to the melting point, and stirring it in with salt. Some water always remains in butter from the whey. A fraudulent amount may be detected by melting it, and allowing it to stand near the fire in a bottle, when all the water will settle at the bottom. The adulteration with lard is peculiar to this country, because lard is here so much cheaper than butter. Dr. Hoskins assures us that he often found as much as 30 per cent of lard in butter, and this by no means always in butter bought from the meaner stores. Lard may be detected under the microscope by the crystals of margaric and stearic acid. Lard itself is adulterated with flour, and very largely with water, often to the amount of 25 per cent. It is also often improperly made from the fat of the intestines of the hog, which gives a soft, poor, and filthy lard.

We are inclined to think that sugar is in a better state in this country than it is in England. Our supply is near, abundant, and cheap. At the same time, it is well to look at its chief sources of adulteration, since more or less of them are found here. Sugar is of two kinds: cane-sugar, made from the sugar-cane, and grape-sugar, which may be made by the metamorphosis of starch or woody fibre, and is called glucose. There are also the beet-sugar, sugar of milk, etc., with which we have nothing to do. The practical difference between cane and grape sugar is in the much greater sweetness of the former. If, therefore, much grape-sugar is mixed with that which is bought for cane-sugar, the purchaser is defrauded; and as grape-sugar may be produced by the action of sulphuric acid on woody fibre, if it is designedly made and introduced, it becomes an adulteration. Really, almost all cane-sugar contains a portion of grape-sugar; but unless in very large amount, it is probably produced naturally by a chemical change in the lignine and starch of the cane. Some years ago glucose was manufactured in England, cheaply, from potato-flour, and used for the adulteration of cane-sugar. But the excise authorities having imposed a duty on it, it ceased to be made. It is sufficient to indicate this source of falsification.

Other causes of impurities in sugar are vegetable albumen, from the manufacture and grinding; blood, used in clarifying white sugar; lime, from the refining; starch, from adulteration with flour; rarely lead or iron, from vessels in which it is prepared; very commonly sand or grit, both accidental and fraudulent; "handling," by which is meant the putting together much of a good sugar with some of inferior quality; and lastly, in brown sugars, the presence of animalcules and fungi. The *Acarus sacchari*, or sugar-mite, is a disgusting parasite of the itch-insect species, whose *habitat* is brown sugar. Like all other animals, he must find some nitrogen on which to live; and since sugar itself contains none, he must get it from the impurities in the poor varieties. It is accordingly found that *Acari* are numerous in proportion to the dirtiness of the sugar. There is another insect of the same class, the *Acarus farinæ*, in damaged flour. Now it curiously happens that both bakers' and grocers' apprentices are liable to an eruptive disease of the hands, called the bakers' or the grocers' itch. It seems probable, therefore, that this hitherto mysterious affection is caused by these varieties of the itch-insect. Sporules of fungi are also to be found largely in brown sugars; and as these also need nitrogen, they must derive their nourishment from its impurities. In 36 samples of brown sugar Dr. Hassall found *Acari* in 33; and in 19 of them, in great numbers; sporules of fungus in 10; sand in 11; grape-sugar, albumen, woody fibre, and starch in all; and in 4 the starch was in fraudulent amounts. In 51 samples of white sugar he found flour in 15, but other impurities were less. Again, in 36 brown sugars he found *Acari* in all (and some swarmed with them); adulterations of tapioca and potato-flour in 2. Dr. Hassall concludes that the brown sugars of commerce are generally unfit for human use. In Boston the only adulteration of white sugar seems to be with flour. The granulated sugars appear pure, but in the moist and dark browns sugar-mites could doubtless be found.

The cunning Chinaman so exhausts the fertility of his fraudulent invention in the preparation of tea, that it would seem as if no other sophistication were left for home manufacturers to practise. Yet they find many, both in substituting other leaves for tea-leaves, and in re-making and mixing teas. Some people even assert that we never get any fresh, unused teas from China. The principal adulterations of black tea, according to Dr. Hassall, are the use of leaves other than those of tea, the re-preparation of exhausted tea-leaves, and the employment of substances to impart color and astringency to the infusion, or to glaze and face the surface of the dried leaves. It is stated, on good authority, that the Chinese annually dry millions of pounds of the leaves of the ash, plum, and other trees, to mingle with teas. These frauds cannot be detected without the microscope, but with it are very readily perceived. Even when the leaves are ground and reduced to powder, as in lie tea, a fraudulent commodity made of tea-dust gummed together and colored, the microscopist can recognize the species of the leaf from a minute fragment, by the size and form of the epidermic and chlorophyl cells, the stomata, and other particulars. The leaves of the sloe, willow, hawthorn, plane, oak, beech, elder, elm, and many others, are used to adulterate tea.

The fraud of re-vamping exhausted tea-leaves may be detected chemically, since the tannin, coloring matter, and theine are much reduced in amount, and the lignine increased, by the addition of foreign leaves and stalks to make up the mass of supposed tea. Black tea should contain of lignine about 46 parts, and of tannin 42 parts in the 100. In the exhausted leaves, sold as good tea, the lignine is often increased to 80, and the tannin sinks to from 1 to 5 parts. To restore the taste somewhat, powdered catechu is added. This may be found in masses under the microscope. Many false articles are sold in London to improve the taste of these exhausted teas. As, for example, to copy a label, — "Great Economy to Tea-Drinkers, La Veno Beno, The Chinese Tea Improver," "four times the strength of the strongest teas," "will make quarter of a pound of tea last as long as half a pound." Analysis: *Sumach-leaves and powdered catechu.* Again, "The Chinese Botanical Powder, or Chinese Economist," consists of catechu and wheat-flour.

It is difficult to make exhausted tea-leaves resume their former curled state. This is done by steeping them in a solution of gum; and sulphate of iron is added to deepen the color. Logwood and talc, or China clay, are used to give a bloom, and, worst of all, many black teas are faced with plumbago, or black-lead, which reduces the cup of tea to the same chemical constitution as stove-polish. *Lie tea* is a falsification composed of tea-dust, or fragments of other leaves, stuck together with gum, and glazed and colored with more or less unwholesome pigments. This is used to mix with other teas. Dr. Hoskins is convinced of its use in this country, from having seen chests of it in tea warehouses in New York. It is made often elsewhere than in China. It appears from Dr. Hassall's analyses, that the common Congous and Souchongs are more genuine than the fancy and scented teas, as Pekoe, Caper, and other varieties. Of 35 samples of black tea, 12 were adulterated with black-lead, indigo, turmeric, and tea-dust. The fabrication of spurious black tea is extensively carried on in London.

Green tea is somewhat mixed with other leaves in China, but its worst adulteration is in the artificial coloring of the leaves. It is said that the color and bloom of all green teas are entirely unnatural. The colors used are three, yellow, blue, and white. Prussian-blue, or ferrocyanide of iron, is the most frequent blue. It is not positively poisonous, but sometimes injurious. Chromate of potash is a yellow color, irritant and caustic. Gypsum, soapstone, mica, turmeric, indigo, and clay are also used in China. All these poisons have been seized with, or found in, spurious teas in England. In 30 samples of green tea, as imported from China, all were found adulterated. Five consisted of lie tea, all were artificially glazed and colored. The blue in 28 instances was Prussian blue. Not a genuine leaf was found, free from artificial glazing, which presented a green color. Of 20 samples of green tea purchased in London, all were adulterated. Foreign leaves, exhausted tea-leaves, and lie tea composed the "British teas," made in England. It is needless to add that Dr. Hoskins finds the same frauds in teas in the United States. Black teas are not now so much adulterated as green. But the latter are going out of use; and then, no doubt, the whole attention of the adulterators, both abroad and at home, will be turned to black tea.

Ready-ground coffee has long been regarded with a suspicion, which unfortunately is too well deserved. Until the improved use of the microscope, there was no certain way of detecting its adulterations. Now, however, it is perfectly easy to do so. Nor does the roasting of the berry interfere, since the parts, although charred, still preserve their characteristics. It will be readily understood, also, that grinding is no obstacle, since the finest powder exists as large lumps under the microscope. Coffee is easily distinguished from its principal adulteration, the root of the chiccory, or wild endive, by the presence in the woody fibre of the latter of dotted or interrupted spiral vessels, which do not exist in the former. The various farinæ of the *Gramineæ* and *Leguminosæ*, as the flour of wheat, corn, beans, and pease, also present a characteristic network, or reticulation of their cells. Of the first 34 samples analyzed by Dr. Hassall, 31 were adulterated with chiccory, 12 with roasted corn, 1 with beans, and in many instances the proportion of coffee was very small, as one fifth, one fourth, or one half of the whole article. In a second series of examinations, after fair warning had been given, of 42 samples of ground coffee, labelled with the most attractive testimonials of its strength and purity, 31 were found adulterated with chiccory, as before. Canister coffees, put up and sold in tin cases, were found the worst of all, adulterated very largely with chiccory, beans, and acorns. The reason of this is obvious, when we learn that the package is sold for the same price as the ground coffee by the pound, and that the customer must be made to pay for the tin canister without his knowledge.

The use of chiccory with coffee has been speciously defended as not only harmless, but salutary. Chiccory, succory, or wild endive, belongs to the same natural family as the dandelion. The root, roasted and ground, is used. It contains nothing which can be regarded as a substitute for the virtues of coffee. It has neither the alkaloid caffeine, nor the aromatic volatile oil, nor anything analogous to them. It consists of cellulose, gummy matter, glucose, and a bitter extractive, of which the latter only can by any possibility possess active properties, and this is destroyed and disappears in roasting. On the other hand, well-roasted coffee yields 37 per cent of extractive to boiling water, of which one fourth are nitrogenized matters, highly nutritious. The aromatic essential oils, and particularly the *caffeine*, are regarded as fulfilling very important dietetical functions. Chiccory contains nothing of the kind. An interesting experiment was made by three persons drinking pure chiccory for breakfast, on three separate occasions. Each time they experienced a feeling of drowsiness and weight at the stomach, and great indisposition to exertion. On the first trial, in two headache set in, and in the third the bowels were relaxed. But it is said that these evils do not result from chiccory mixed with coffee. Two persons partook, for a considerable period, of coffee largely adulterated with chiccory, and during nearly the whole time they suffered more or less from diarrhœa. It will be seen, then, that no possible results can be gained from mixing chiccory with coffee analogous to those of the pure berry. Chiccory is wholly inferior, inert, and even hurtful.

Another argument has been used, that the mixture of chiccory and coffee affords a cheap beverage for the poor. The answer is, that chiccory is so much cheaper than coffee, that any such mixture sold under the name of coffee, and at anything like the ordinary prices, can only be an atrocious fraud. Moreover, in speaking of ground coffees, it must be remembered that many poor persons cannot afford a coffee-mill to grind their own, and thus protect themselves from adulteration. Chiccory itself is also largely adulterated with cheaper, and even worse articles; as with carrots, parsnips, mangel-wurzel, lentils, biscuit-powder, burnt sugar, and a red earth. In twenty-two analyses of chiccory, nearly one half the samples were found adulterated. Chiccory grows wild on the road-sides in this vicinity, and Dr. Hoskins found this substance and pease the chief adulterations here.

Genuine cocoa contains 53 per cent of fatty matter, 16 per cent of aromatic albuminous matter, 10 per cent of starch, and nearly 8 of gum. It will thus be seen, that in its pure state it is a very concentrated and nutritious, as well as agreeable food. As it is much used by invalids, it is particularly important that it should be pure. The cocoa-seed has certain tubular fibres and enlarged cells, which distinguish it; crystals of margarine and its starch corpuscles are also peculiar to it. Different parts of the seed and husk are sold under the names of nut, shells, flake, granulated, and soluble cocoa. It is adulterated with foreign fatty matters, which become rancid on exposure to the air, with excessive amounts of starch, which the microscope will assign to their respective plants, with sugar, and with red coloring earths. In 56 samples, sugar was found in 43, starch in 46, in the form of wheat or potato flour and sago-meal, and in proportions varying from 5 to 50 per cent. Chocolate is a manufactured article, best made with sugar and the starch of arrowroot. Other starches are found in many samples, but they are not objectionable unless in excess. In another analysis, by Dr. Hassall, in 68 samples of cocoa and chocolate, 39 contained earthy coloring substances, consisting mainly of red ochre. We are very glad to learn from Dr. Hoskins, that American cocoa and chocolate, prepared in this neighborhood, are quite pure and good.

But it is above all in articles of diet for the sick that adulteration is the most universal, as well as the most wicked.

The various farinæ, especially, are much sophisticated, and the numerous high-sounding patent preparations of invalids' food are mostly worthless. Arrowroot, when pure a most efficient and soothing article of diet, suffers much from admixture with inferior starches and flours. The Maranta arrowroot, obtained from the *Maranta arundinacea*, is the original variety, and the most valuable in all its qualities. It commands from one to three shillings per pound in London, and one table-spoonful will gelatinize a pint of water. There are many other and inferior varieties, which can be recognized under the microscope by the different shape and size of their starch-cells. Such are the *Curcuma*, *Tacca*, and *Manihot* arrowroots. And, besides these, there are adulterations with sago-meal and potato-flour. A favorite receipt with the adulterators is equal parts of the two last-named articles. Of 50 samples of arrowroot, 22 were adulterated, in all cases with sago, tapioca, or potato. Ten of the specimens contained scarcely a particle of genuine Maranta arrowroot, and some consisted *wholly* of potato-flour.

It would hardly be supposed, says Dr. Hassall, that so cheap an article as oat-meal would pay for its sophistication. Yet of 30 samples examined, more than half were adulterated with large quantities of barley-meal. This might appear of slight importance, if we did not consider that oat-meal forms so frequent an article of daily food for both adults and children in the English workhouses. Oat-meal costs 14*s.* per hundred-weight, barley-meal only 7*s.* Pereira thus describes their relative value as food.

> "With the exception of maize, oat-meal is richer in oily or fatty matter than any other cereal grain, and its proportion of protein compounds exceeds that of the finest English wheaten flour. So that both in heat and fat making, and in flesh-making principles, it holds a high rank. . . . . . Barley-meal contains less of the protein principle; its starch offers more resistance to the gastric juice; its husk is acrid, if not carefully removed, and it is more laxative."

That these changes may make a fatal difference to the poor under-fed children of many Union almshouses, is proved by an inquest held by Mr. Wakley over the bodies of certain young victims of disease, whose chief food was oat-meal largely adulterated with barley.

But the most unblushing frauds appear in the patent articles of food and diet. Foremost among these are the preparations styled *Ervalenta* and *Revalenta Arabica*, two rival articles extensively sold in England and here. One is described as an "agreeable, nutritious, farinaceous food; cures constipation and indigestion; a most suitable diet for children, aged persons, and invalids generally. Its eminent properties as a curative dietetic have been acknowledged by the first physicians and analytical chemists of the day." Price 2*s.* 9*d.* the pound. Then follow certificates of all kinds. The other is "Du Barry's Revalenta Arabica, or Health-Restoring Food, for invalids and infants; discovered, exclusively grown, and imported by Du Barry & Co. . . . . . This light and delicious breakfast farina speedily removes dyspepsia, constipation, acidity, heart-burn, diarrhœa, nervousness, biliousness, palpitation, eruptions, scrofula, debility, sleeplessness, involuntary blushing, melancholy, indecision," &c., &c., &c. Price, the same as the other, and certificates quite as good. Then we have a long caution about imitations; and finally this closing statement: "Cruel deceptions on Invalids exposed. The health of many invalids has been fearfully impaired by spurious compounds of pease, beans, and lentils, palmed off on them under similar names, such as Ervalenta, and so forth, but Du Barry's Revalenta has obtained the highest testimonials of cures. We give the description, from the Pharmacopœia, of the bad qualities of the Lentil: '*Ervum Lens* (Lentil), difficult of digestion, astringent, hurtful to the eyes, and producing weakness of the extremities.'" On analysis it was found that the Ervalenta and Revalenta Arabica were very similar in composition, being made, respectively, of the *French* and *Arabian Lentil*, sweetened and nicely put up. Says Dr. Hassall: "We recently partook of some of Du Barry's Revalenta Arabica, and found the flatulent effects so unpleasant, that we would not willingly repeat the experiment." It is practically equivalent to pea or bean flour.

Among other high-sounding farinæ, we find the following: "By her Majesty's Royal Letters Patent. *The Prince of Wales's Food.* Patronized by the Faculty. This article is decidedly superior to arrowroot, tapioca, isinglass, &c.; it never becomes acid on the stomach, and is peculiarly valuable for thickening soups, and making delicious puddings and blanc-mange. Price 1*s*. This unrivalled preparation is justly considered one of the greatest triumphs of vegetable chemistry of which the present age can boast." An analysis of the Prince of Wales's Food proved it to consist entirely of *potato-flour*. So, too, "Leath's Homœopathic Farinaceous Food" consists of wheat-flour, potato-flour, and Indian meal; "Maidman's Nutritious Farina," of potato-flour, colored with rose-pink; "Hard's Farinaceous Food," and "Braden's Farinaceous Food," of wheat-flour, baked or browned; "Jones's Patent Flour," of flour, tartaric acid, and soda; "Baster's Soojie," of wheat-flour sweetened with sugar; and "Palmer's Vitaroborant," of lentil and wheat flour.

Isinglass is made from the swimming-bladder of the sturgeon. It is both expensive and valuable as a delicate food for invalids. It contains naturally some gelatine. Gelatine is made from old bones, old hides, and such sources, and is both an inferior and cheaper article. It is hence used to adulterate isinglass. Of 28 samples of isinglass analyzed, 10 consisted entirely of gelatine.

Vinegar owes its agreeable pungency to a volatile principle, acetic acid. This is the next stage in fermentation after the formation of alcohol. Good vinegar should contain not less than *four* per cent of acetic acid. The four principal vinegars of commerce are made respectively by fermenting wine, malt, and sugar, and by the destructive distillation of wood. The principal adulterations of vinegar are dilution with water; the addition of sulphuric acid; the substitution of pyroligneous for acetic acid; the use of burnt sugar to color, and of acrid substances, as Chili peppers, to give pungency. The addition of a very small amount of sulphuric acid to keep malt vinegar is allowable. In small quantities it is harmless; in large proportion, injurious to the coats of the stomach. As it is a cheap and powerful acid (oil of vitriol of commerce), it is a favorite adulteration for poor vinegars. It is detected chemically. As the result of analyzing 28 samples of vinegar, we have the acetic acid ranging from 5 to 2½ per cent.; 18 were adulterated with sulphuric acid, — in 9 samples in considerable amount, and in 7 in immense quantity. Dr. Hoskins found a great part of the vinegar sold in Boston below the standard strength, and a number of samples adulterated with sulphuric acid.

Of course this species of vinegar is to be found in pickles; but other poisons await us there. "People ask," says Dr. Hassall, "'What! are not the gherkins, cabbages, beans, &c. which we see in the bottles what they appear to be?' Gherkins often turn out sliced cucumbers; the beans are old and tough, the cauliflowers run to seed, and the red cabbage is often dyed white cabbage. There are also other illegal contents, as vegetable marrows, sliced turnips, and some nondescripts, which would puzzle even a botanist." But this is not the only reason that pickles are considered so unwholesome. There is a more deadly ingredient, and that is *copper*, a mineral poison, added to give a bright green color. This vile adulteration is wholly unnecessary, for a fine green can be given to pickles, which are prepared with good vinegar, by the addition of salt. This adulteration is to be detected chemically; but an easy test can be applied, on the table, by inserting a polished knife-blade into the pickle-jar; copper, if present, will be deposited on the steel, in a metallic state. In 16 samples of pickles analyzed, the vinegar ranged only from 1.48 to 2.91 per cent; all contained sulphuric acid; all contained copper, — in 12 in very considerable amount, and in 3 in absolutely poisonous amounts. It is, perhaps, useless to try to prove the unwholesomeness of so violent a poison as copper. Two thirds of the American pickles examined were found to contain this poison. The moral is, Avoid very green pickles, and buy the paler tints.

Copper exerts similar verdifying influences on bottled fruits and vegetables. From an analysis of 33 samples, Dr. Hassall found copper in 27, and comes to the conclusion, that preserved *red* fruits do not as a rule contain copper, but that green fruits very generally do, — limes and gooseberries a considerable amount, rhubarb and greengages much more, and olives most of all.

Spices, being sold mostly in a powdered state, offer a facility of adulteration to the grinder which the fraudulent cannot resist. On the comparative catalogue of frauds we may place these commodities as both more, and more generally, adulterated than any other articles. Many inert substances are mixed with them, and this necessitates the addition of still more injurious ones to restore the color, appearance, and pungency. Besides these positive adulterations, vast quantities of old or damaged and inert ginger, mustard, pepper, cloves, and allspice are constantly bought up and ground for sale by the spice-manufacturers. All these falsifications, we learn, have been extensively found in Boston. As we have before indicated, the adulterations of spices are readily recognizable under the microscope. Dr. Hassall found that, of 42 samples of mustard, all were adulterated with immense quantities of wheaten flour, colored with turmeric; and he concludes that *genuine mustard* is scarcely ever to be obtained. Ginger, in 15 out of 21 samples, was found adulterated with sago-meal, potato-flour, wheat-flour, ground rice, turmeric powder, and Cayenne pepper. Cinnamon contained the inferior cassia, and wheat, potato, and sago flours in more than one half the samples. Nutmegs are distilled in water, and their volatile oil extracted fraudulently. Mace and cloves were found pretty genuine, and also allspice. But the most fearful falsification is in Cayenne pepper. In 28 samples, 24 were adulterated, — many with ground rice and red ochre or brick-dust, 22 with mineral coloring-matter, 13 with *red-lead* in poisonous quantities, and one with vermilion, or sulphuret of mercury.

Genuine curry-powder consists of turmeric, black-pepper, coriander, cayenne, cardamoms, cumin, ginger, allspice, and cloves. It is found to be adulterated with ground rice, salt, ferruginous earths, and the fatal red-lead. Anchovies are found to consist of other and inferior fish, and the sauce to be colored with bole Armenian, or Venetian red, often so saturated that these earthy powders could be obtained in spoonfuls from the bottom of the jars.

The many sauces which are used as condiments, very largely by the English and to some extent in this country, are also adulterated mixtures. For instance, treacle and salt formed the basis of 5 samples of India Soy examined; in "Lazenby's Harvey's Fish-Sauce" were found oxalate of lime and charred wood-chips, probably used to give color; 6 samples of tomato-sauce were artificially colored with cochineal or the ferruginous pigment, bole Armenian; the essences of lobsters, shrimps, and anchovies were each saturated with this red dirt, harmless perhaps, but more clogging to the bowels than palatable to the mouth. No lead was found in the sauces, but some traces of copper were detected in 4 samples. Copper also was detected in 33 out of 35 samples of jellies and preserves, as raspberry-jam, gooseberry-jam, marmalade, and the like. This demonstrates, says Dr. Hassall, that *preserves made in copper vessels almost invariably contain copper*, and often in considerable quantities. It is very gratifying to learn from Dr. Hoskins, that, so far as his investigations have extended, the French preserved fruits, meats, liqueurs, and confectionery are genuine and free from adulteration. Penal laws and rigid governmental inspection both contribute to this happy result. It is also pleasant to know that the meats and vegetables put up here appear good and genuine. The potted meats of England, of which large quantities are made, are for the most part badly adulterated with red ferruginous earths, as Armenian bole. And this, or the other coloring-matter, Venetian red, is sometimes itself falsified with red-lead. Moreover, it is also very doubtful, when one eats English potted meats, whether he is not partaking of old and bad material, or of some species of animal he never ate of before. Mr. Richardson, officer of the local board of health of Newton, near Manchester, thus testified before Parliament: —

> "We have in Newton five knacker's yards, and there is only one in Manchester. The reason is because they are so much more tolerant in Newton; and it has been a source of great profit to them, because they have the means of selling the best portions of the horse-flesh to mix with potted meats. I can say for a fact, that the tongues of horses particularly, and the hind-quarters, are sold for this purpose."

Vast quantities of such offal were, not long ago, supplied by contractors for the use of the British Navy. Tons of it were examined, condemned, and thrown overboard.

There can be little doubt, from the occasional seizures of diseased meat in the markets, by the inspectors, that very much escapes detection, and is sold in a state unfit for human food.

It has long been known that German sausages and cheese sometimes take on a poisonous action, probably from the development of injurious fungi. Clams, also, and oysters, as well as the wild partridge, seem sometimes endowed with toxical properties. Although no specific explanation can be given, it is at least equally certain that the flesh of animals dying of disease, or slaughtered in a state of chronic ill-health, must be hurtful as food. Much of this vile material must be packed as corned beef, and made into potted meats and sausages, and still more sold directly to the poor, at so cheap a rate as to attract their custom. Such pest-houses as swill-milk stables must furnish large amounts of this meat. One effect of such food we do know by direct physiological experiment. Measly pork is the flesh of pigs infested with a parasite, the *cysticercus*. This pork is often sold for food. It has been proved, by two experiments on convicted criminals, that this will give rise to tape-worms. The convicts were fed with measly pork, or *cysticerci*, a few days before their execution, and on a *post mortem* examination numerous young tape-worms were found.

So far does the habit of adulteration or sophistication extend, that we find even perfumes, which are very readily and simply made from the flowers themselves, manufactured entirely out of an artful combination of essential oils, without one particle of the real perfume of the plant whose name they bear. It would be useless, in this connection, to do anything more than advert to the notorious falsification of wines and spirits. This is not of such vital importance as the purity of food.

Tobacco is probably purer here than abroad. Unmanufactured tobacco was not found to be much adulterated in England. To save the difference of duties, much tobacco is there imported raw, and undergoes domestic manufacture into cigars. There were no graver frauds found in these native-made cigars, than the use of a poor quality of tobacco, or the occasional substitution of the leaves of other plants, or hay for filling them. These are of little consequence. But the adulterations of snuff are more serious. These are of various kinds, to give pungency, color, and smell. They are, — salt, added in large quantities to all kinds of snuff, and ranging as high as 12 per cent; the carbonates of lime and potash; colored ferruginous earths, as red ochre, yellow ochre, and umber; *chromate of lead* in 9 samples, of which 5 were Scotch snuff; and red-lead in 3 samples. When we consider how intimately these various substances are brought and retained in contact with the delicate and expanded mucous membrane of the nose, and probably of the frontal sinuses, it is no wonder that the use of snuff has been found to be more injurious than chewing or smoking tobacco.

There are two other adulterations remaining, if possible more serious and pernicious, as they are more fraudulent, than any that have been spoken of; these are the adulterations of confectionery and of medicinal drugs. It will be recollected that when, by the terrible poisoning case at Bradford, England, many persons lost their lives by eating arsenicated lozenges, which were hawked about the town, it was testified that the mistake arose in this manner. An apothecary's apprentice, receiving his weekly call for "stuff," or gypsum, from a confectioner, went into the cellar and mistook a package of arsenic for the lime required. It was thus conclusively proved that white lozenges were systematically adulterated with sulphate of lime. Dr. Hassall finds this to be the case now, while much flour is also used. But it is the fancy-colored confectionery which furnishes the most poisonous adulterations. All the gay colors are liable to be produced by violent mineral poisons. The colors used are chiefly red, yellow, blue, green, brown, and purple. In 100 samples of colored confectionery analyzed by Dr. Hassall, the colors were found to be as follows. Of the reds, 61 were colored with cochineal, 12 with red oxide of lead, and 6 with vermilion, or bisulphuret of mercury. Of the yellows, 59 were colored with chromate of lead, and 11 with gamboge. Of the blues, 1 was colored with indigo, 11 with Prussian blue, or ferrocyanide of iron, 11 with Antwerp blue, a modification of the above, and 15 with German ultramarine, a silicate of alumina and soda. Of the browns, 8 were colored with ferruginous earths. The purples betrayed a mixture of Antwerp blue and cochineal. Of the greens, 10 were colored with

Brunswick green, a mixture of chromate of lead and Prussian blue, 1 with verditer, or carbonate of copper, and 9 with Scheele's green, or arsenite of copper. What an apparatus of death! Moreover, the colors were so combined, that from three to seven colors occurred in the same parcel of confectionery. Gamboge is a drastic cathartic; Prussian blue, Antwerp blue, and German ultramarine are injurious; while the chromates of lead, red-lead, vermilion, the Brunswick greens, verditer, and Scheele's green are *deadly poisons!* Further, it appears that the ornaments on cake are painted on with white lead; and bronze powders, an alloy of copper and zinc, are employed in certain kinds of colored confectionery. Nor is the use of these mineral pigments at all necessary; for the Council of Health of Paris have furnished a very full list of innocent vegetable colors.

Those who defend their practices in employing mineral substances to ornament confectionery say, that the colors contain such infinitesimal amounts of poison, that no harm can ensue. But this is entirely false; for repeated cases of poisoning have occurred, and enough of the pigments have been scraped off from even small pieces of this confectionery to kill animals as large as a rabbit. It is also to be considered that these articles are eaten principally by very young children; and also, that these mineral poisons are cumulative, so that repeated almost infinitesimal doses will gradually accumulate in the system, which is unable to throw them off, until a poisonous and even fatal amount is reached. That even a single article contains sometimes a fatal dose, the following case proves. Mr. Hetley, of Marylebone Infirmary, being called to see some persons suddenly ill, found *three adults and eight children* severely affected with vomiting. Their mouths were colored green. It was found that they had all partaken of a cake of confectionery which had cost only two-pence. It was a thin cake of sugar and plaster of Paris, covered with a *bright green* coat. At Nottingham, England, twenty-one persons were poisoned at a public dinner, by partaking of a blanc-mange, the top of which was colored green with arsenite of copper. Again, Dr. Fergus published the cases of three children who were poisoned by eating the sugar ornaments of a twelfthcake. Numerous cases are recorded in this country. As Dr. Hoskins well says: "How many children have expired in sudden convulsions, where no one ever suspected the virulent cause in the apparently innocent, gayly-colored sugar-plum, clasped in its little hand, perhaps even in its dying struggles. I write somewhat warmly upon this subject, for I happen to have seen one such case myself. I hope never to see another."

It follows, then, that all colored confectionery is to be carefully avoided; and that even the tinted papers in which it is wrapped should be kept out of children's way, as almost equally poisonous. Yet children are very fond of sugar, and it is good for them physiologically, as now proved, to help the bone-making function. And we suspect that much of the unwholesomeness of candy is to be ascribed to the adulterations, rather than the sugar. By confining children to the white candies, exclusively, we shall at least be sure that they are eating nothing worse than flour, whiting, and gypsum, or sulphate of lime.

The adulteration of substances used in medicine is probably fully as great as, if not greater than, that of articles of food, and it is rather by the substitution of poor and inert articles for genuine and efficient ones, than by the admixture of poisons. The remarks made with regard to spices hold good here with tenfold force. The amount of poor, old, worm-eaten, and improperly prepared or damaged drugs which are ground up and thrown into the market is something enormous, and the state of things, we have every reason to think, is even worse here than in England. No physician can have failed to notice the very different effects produced by the same dose of such drugs as ipecac and opium, given under similar circumstances, to patients of the same age. Idiosyncrasy is not enough to explain this entirely. The same dose of an opiate powder which failed in our hands in producing any effect on a child of three years, made another child of five years sleep for twenty-four hours; or, in other words, completely narcotized it. The like is true of many other articles, and while we cannot doubt of the existence of much falsification here, we can give the proofs of certain analyses made in London.

To show first the inequalities of manufacture, we will cite the London Lancet of 1853 – 54. Good laudanum should contain, if of a standard quality, — and it should be all made alike by maceration in alcohol fourteen days, — about one grain of opium to 19 minims of laudanum. In 21 samples analyzed, the amount varied from one grain in 4 minims, to one grain in 34 minims. Or, in other words, a person taking the average dose, of about 25 drops of laudanum, would get, in the one case, nearly five grains of solid opium, a poisonous dose; and in the other case, hardly more than half a grain, or much less than the average dose. Again, to speak of differences in the raw drug, of 23 samples of solid opium, 19 were adulterated with poppy capsules and with wheat-flour; and the proportion of the alkaloid, or active principles, varied from two to fourteen per cent. Opium containing only two per cent of morphine must be sophisticated. Again, of 32 samples of powdered opium, *one* only was found genuine, the rest being adulterated with flour. So much for the most valuable agent of the Pharmacopœia, to which so many sufferings yield, but toward which so many sufferers must look in vain, if such adulterations are practised.

Other drugs fare as badly. Of 33 samples of ipecacuanha, 18 were adulterated with chalk, wheat-flour, starch, and woody fibre; and in several cases, in order to restore the emetic properties, which these inert substances had reduced, with large amounts of tartar emetic, a much more violent article. Scammony was mixed with wheat-flour, chalk, lentils, woody fibre, sand, and colored earths. Of 33 samples of jalap, 14 were adulterated with woody fibre, down to one third their genuine strength. All other drugs, doubtless, suffer equally. These sophistications probably take place in the drug-grinders' hands. We do not believe that the retail druggists are guilty of them; but they do not all test, or know how to examine, their drugs, and the fraud passes unsuspected by them.

It seems reasonable to conclude, that much of the present scepticism about the use of medicine has had its origin in the inertness, and hence the doubtful effects, of drugs. It is certainly not conducive to faith in therapeutics — at all times subject to so many other unavoidable doubts — to give opium deprived of its morphia, ipecac robbed of its emetine, or chalk and flour for a cathartic; or to expect, in vain, from them any perceptible effect. The sugar globules of the homœopath may be, therefore, as powerful as the most heroic of regular doses. And these frauds, of course, equally shake the tottering faith of the patient, and often drive him into the arms of a system which, when honest, is inert; instead of remaining to be treated by the old way, which is effective in proportion to the genuineness of its weapons.

Many other evils arise from adulteration. The physician, besides the vast array of natural diseases which he is called on to diagnose and combat, must now be constantly on the watch to trace maladies to some secret mineral poison, or to some unsuspected fraud in diet, which he had not thought of, or feared before. For we have seen the fraudulent, repulsive, and even poisonous adulterator thrusting his fatal finger equally into the scanty gruel of the pauper, and into the rich man's fancied arrowroot, or farinaceous delicacy. From the solid food of adults to the playthings of children, from the kitchen to the nursery, and thence to the sick-chamber, unsuspected fraud takes its fatal way, and mingles its last poison in the potion of the dying invalid. This language is feeble in comparison with the fearful truth of those frauds, thefts, adulterations, and poisonings which statistics prove to follow us all, from the cradle to the grave.

Adulteration, too, exercises its immoral influences upon trade, — encouraging fraud, and discouraging the honest trader by a ruinous system of underselling. He who sells only genuine articles, at their real cost, can thus stand no chance in competition with the vendor of adulterated goods. Apart from its effects upon the stomach and the health, these frauds also exercise a vast influence upon the pockets of the whole community. To view them in the light of political economy, they are an immense public loss of property. But the worst is, that they press hardest upon the slender resources of the poor, who must always live from hand to mouth, and must get their groceries in small quantities, and in a prepared, *alias* an adulterated state. The temptation with them is sore to buy where they can buy cheapest; and damaged flours, diseased meats, and adulterated coffees and teas are always the most attractive, on this account, to the unsuspecting lower classes.

It will be asked, what improvement followed the exposures of adulteration in London, and whether any restrictive laws sprang from them. The effect of the course of the Lancet was immediate and considerable, but it is to be feared that it is gradually wearing out. In 1858, from analyses of certain articles in different towns, it was found that the percentage of adulterations was less. Thus in Birmingham 21 out of 55, in Manchester 25 out of 73, and in Liverpool 22 out of 84, articles examined were adulterated. This was a considerable improvement on the state of things in 1854, when the Analytical Sanitary Commission closed its labors. Many of the best dealers in London, also, corrected unsuspected abuses, and enjoyed the approval of the Lancet for their wares.

The progress of a prohibitory law was slow. The subject of the adulteration of food was brought up in Parliament in 1855, but nothing was done. It was revived in 1859, but failed in all but a restrictive clause on chiccory in coffee. Finally, in 1860, a law was passed with much difficulty. But it was so enfeebled by amendments, and the corrupt power and wealth of the accused had held such weight against it, that it is far from efficient. Its two principal clauses are, first, that it is illegal to sell any article of food or drink adulterated with *unhealthy* substances; and, secondly, that it is illegal to sell *as pure* any article of food or drink which is not pure, but adulterated. For a first offence there is a fine of £ 5; for the second offence, the name of the guilty party *may* be published. The infliction of the only effectual punishment, publication, is thus left optional with the magistrate. Besides this, it is also optional whether an officer, poor-law guardian, or other official prosecute any party, even if he knows that party to be guilty. In addition, the law is defective in not touching the morality of adulteration itself, and in not being prohibitory of even the harmless mixing of articles of food. On the 15th of December, 1860, there were five convictions of bakers for the use of alum; and they were fined £ 5 and £ 10 each. But we fear that not many more fines will be laid. The law did not start until ten years after the Lancet began its exposures; and after all, it is lenient, and easily evaded.

In Paris, the law is severe on adulterations of every description, and on short weights. For the first offence there is a heavy fine. For the second, the convicted party has to fix a placard in his window, stating his guilt, and to leave it there at the pleasure of the court.

Dr. Hassall recommends that the retailer should protect himself by never buying any prepared articles below the cost of the raw ingredients; for many ground spices are sold at less price than the unground article. It is very easy to draw the right inference. Also, the retailer is advised to require a guaranty of purity from the manufacturer or wholesale dealer; and the latter might get his certificate from a public analyst.

In Massachusetts, we have very few restrictive laws on such subjects; and even these — as the laws relating to the weighing and stamping of bread, and the sale of milk — are a dead letter, and inoperative. When we see the difficulty of passing an effective law in England, as compared with the more positive and executive governments of the continent of Europe, we may form some idea as to the possibility of enacting prohibitory statutes against adulteration in this country, and of executing them afterward. There are few journals that have either the courage or the position and ability of the Lancet to expose these frauds; besides which, the result of such exposures can be only temporary. The best that can be done is to enlighten the public thoroughly and frequently as to what they are unconsciously suffering, through the press; and finally public opinion may take up the subject, and pass laws and enforce sufficient penalties. Until then, we fear that the defrauded consumer of adulterated foods can have as his only safeguard that insufficient maxim of jurisprudence, CAVEAT EMPTOR!